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ABSTRACT

Asserting that developmental growth is easier to attain in developing countries than social change, this paper assesses the prospective impact of biotechnology on the developing nations. Biotechnology is defined as the integrated use of biochemistry, microbiology, and chemical engineering to achieve the industrial processes of fermentation, enzyme reaction, and genetic engineering. This paper examines biotechnology's impact on agriculture, industry, health, and defense and considers its role in the processes of economic, social, and political change in developing countries in terms of: (1) the structure of the global biotechnology industry; (2) past lessons learned from the worldwide industrialization of agriculture (the Green Revolution); (3) current and future trends in the development of biotechnology; and (4) minimizing damage and maximizing benefits for developing nations' populations. (JHP)

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Biotechnology and the Third World: Panacea or Recipe for Social Disaster?

Ward Morehouse

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Biotechnology and the Third World: Panacea or Recipe for Social Disaster?

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Council on International and Public Affairs
and Columbia University, New York
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Note: This paper is based on a lecture presented to the Academy for Educational Development in its International Division Twenty-Fifth Anniversary Series in Washington, D.C. on October 30, 1986. It was revised and expanded as a background paper for the Tenth Symposium on Law and Development at the University of Windsor, Ontario, Canada, November 5-8, 1986.

Much of the analysis and many of the ideas contained in this paper are drawn from the collaborative efforts of the Social Impacts of Biotechnology Research Group, a joint undertaking of The Council on International and Public Affairs (CPIA) and the International Center for Law in Development (ICLD). While absolving them from responsibility for the particular formulation presented here, I acknowledge with grateful thanks the numerous inputs from my two colleagues in the Biotechnology Group, Clarence Dias for ICLD and David Dembo of CIPA. Citations of some of our joint work on which I have drawn extensively are given in the notes at the end of the paper.

DEVELOPMENT GOALS AND TECHNOLOGICAL REVOLUTIONS

The goals of development provide the critical benchmarks for assessing the likely impact on the Third World of technological revolutions such as are occurring in biotechnology. My point of departure for identifying the goals of development which I consider crucial is the Universal Declaration of Human Rights. This is, of course, a normative document—a set of propositions of what should be rather than what is. In the Universal Declaration of Human Rights it is asserted that all people on this troubled planet of ours shall have the right to food—which I would further articulate as the right to feed themselves—to decent shelter, to good health—or at least some sort of rudimentary health care—to education, and to productive and meaningful work. To this list I would add, as absolutely critical in achieving the foregoing rights, what might be called the enabling rights of participation and empowerment.

On the by now old-hat debate of growth versus equity in development circles, I need to make two observations in establishing the context for my assessment of the biorevolution in the Third World. The first is that another critical objective needs to be added to equity so that the revised formulation of the debate topic reads "Growth Versus Equity and Sustainability". The second is that my own personal balance sheet of development priorities comes down overwhelmingly on the side of equity and sustainability.

I am not interested in growth as such except to the extent that it enhances equity and sustainability. All too often, growth has become an end in and of itself, adversely affecting rather than enhancing equity and sustainability.

This is, of course, a very tough standard. Growth, while not always easily achieved, is nonetheless much easier to accomplish than social change which increases equity and is sustainable environmentally and without continuing external interventions.

This set of normative goals provides the context for the following assessment of the prospective impact of biotechnology on the Third World. The standards by which I shall judge the role biotechnology is likely to play in the Third World will be the extent to which it facilitates or frustrates the realization of the basic rights to food, shelter, health, education, and work, as well as participation and empowerment, and to what extent it furthers or inhibits self-reliant, equitable, and sustainable social change in the poor countries, especially among the poor in those countries.

Certainly we live in an age of technological microelectronics. Most of us are increasingly conscious of the impact of microelectronics on our daily lives. Even in the Third World, the revolution in microelectronics is being more and more widely experienced.

THE BIOREVOLUTION: DEFINITION AND IMPACT

The Biorevolution—the revolution in biotechnology—is perhaps not so far advanced in its evolution as microelectronics, but quite possibly one with the potential for having an even more pervasive impact on the lives of hundreds of millions of people on this planet, certainly including those in Third World countries. It is a revolution that begs definition because its means so many things to so many different people. In its broadest sense it comprises industrial processes that are based upon applications of fundamental biological knowledge, particularly in microbiology. A somewhat more limited definition involves the integrated use of biochemistry, microbiology, and chemical engineering in order to achieve technological application of microbes and cultured cells.

Whatever definition is used, biotechnology is usually assumed to encompass three major industrial processes that are based on biological systems—namely, fermentation, enzyme reaction, and genetic engineering. Of these three, it is the last that is generally thought to have the most significant potential, since it can lead to commercial production of custom-designed microbes and can be used in fermentation and enzyme reaction.

Let us look at the potential impact of this technological revolution in four major areas—agriculture, industry, health, and defense.

1. Agriculture

In agriculture, there are many different ways in which biotechnology will have, and to some degree already has had, an impact. Research based on biotechnology encompasses a range of concerns in agriculture, including crop yield improvement, achievement of nitrogen fixation in non-leguminous crops, enhancement of photosynthetic activity, manipulation of growth and regulation, and improving stress tolerance.

Clearly, with that kind of agenda, breakthroughs in such research are going to be of great importance to both industrialized countries and Third World countries that are faced with similar problems of soil exhaustion and soaring costs of chemical and energy-intensive agriculture. Third World countries face some additional problems that underscore the potential importance of biotechnology—for example, displacement of domestic food crops by crops destined for export, degradation of the environment (including desertification), soaring foreign exchange costs, and of course, the increasing pressure of population on food production capacity. Indeed, it might be said that Third World countries are faced with the dilemma of having to improve simultaneously both production and consumption of food, qualitatively and quantitatively.

Conventional plant breeding methods take time. One of the great hopes for biotechnology is that it can accelerate the process of plant breeding to achieve desired qualities or outcomes more quickly. This involves tissue culture and gene-splicing practices that can be used to increase genetic variations in cells and ultimately to eliminate barriers that prevent different species from mating.

Biotechnology is also going to have its impact on animal health and husbandry both through vaccines that seek to control animal diseases and through growth of hormones. We all can imagine a super chicken as the next manifestation of Mr. Perdue on our television sets. Certainly, biotechnology offers distinct possibilities for the development of improved reproductive technologies such as the development of new embryology technologies that will make it possible to breed not only super chickens, but also super cows, super pigs, super goats, and super sheep.

In short, in the critical realm of agriculture on which in many ways all other life depends, biotechnology has the potential to make extraordinarily valuable contributions to stimulating agriculture production, by reducing dependence on chemical imputs, by speeding up the plant-breeding process, by developing plant varieties with increased yields and stress resistence, and by increasing yields and reducing disease in animals.

2. Industry

Industry is the second major area of impact for biotechnology. Its potential application across a wide range of industrial activity makes it difficult to speak of biotechnology as though it were a unitary phenomenon. It is not, of course. It is a set of processes, a variety of ways of applying

knowledge to productive activity; and its horizontal impact across a wide range of industrial sectors is what gives it such revolutionary potential.

The importance of fermentation, one of the oldest industrial processes still in use today, has already been mentioned. Fermentation is used in the production of such useful substances as antibiotics, ethanol enzymes, sugars, and flavoring agents. Many believe that the chemical industry is going to be revolutionized in the next decade or two by applications of this technology. In a synthetic process, microorganisms, at least in theory, can accomplish in one step results that would involve several steps in a conventional chemical process, and do so with significantly diminished levels of pollution.

Moreover, while chemical processes are energy and capital intensive, biological processes operate under much milder conditions, usually do not require high temperatures or pressure, and have at least the potential of being relatively capital saving. These processes are also susceptible to descaling—that is, smaller units of production can operate just as efficiently as much larger units.

Beyond the chemical industry, where biotechnology will certainly have an impact on a variety of products such as plastics, raisins, flavors, perfumes, and pesticides, it is clearly going to have major impact in the pharmaceutical industry. Some of the very first products to go into commercial production based on the more advanced techniques of biotechnology have been pharamceutical products, such as human insulin, interferon, and animal and soon-to-come human growth hormones. The food-processing industry is certainly another major area which will feel the impact of biotechnology, as is energy, where the technology also has much to offer. By way of illustration, biotechnology provides a means of substituting energy based on biomass production for energy involving petroleum products, a critical concern to oil-importing developing countries.

3. Health

The third major area of impact is human health. The potential biotechnology offers for the pharmaceutical industry already has been mentioned. Scientists are now exploring ways of using monoclonal antibody methods to develop more accurate and sensitive diagnostic tools. Immunology research is adopting methods based on genetic modification of certain tissues. Recombinant DNA methods are being used to develop vaccines for a variety of infectious and parasitic diseases that have thus far defied our efforts to contain them.

4. Defense

Defense is an area of potential impact rarely mentioned in discourses on biotechnology but one that is critically important in sketching the landscape for this late 20th century revolution in technology. The so-called frontier technologies like biotechnology are perceived to give a competitive edge in the global political economy to those nations with the capacity to develop and use them. That competitive edge extends to military and defense application as well. We have begun to see a little bit of this range of possible application surface in the media. Presumably that is the tip of the iceberg.

There is research underway, for example, that seeks to immunize whole populations against agents of biological warfare without their even realizing it. The side in any military conflict that possesses this capability will thus be able to use those biological agents with impunity on its adversaries.

It can be seen from this very brief sketch that biotechnology has the potential for great human benefit, but also for great harm to people at all levels of development in both industrialized and developing countries alike.

THE STRUCTURE OF THE GLOBAL BIOTECHNOLOGY INDUSTRY

In considering what kind of role biotechnology is likely to play in the processes of economic, social, and political change in the Third World, it is necessary to look at the emerging structure of the global biotechnology industry. The first thing to be said is that the structure of this industry and the supporting scientific activity on which industrial applications are based reflect the global distribution of scientific and technological effort among industrialized and Third World countries. It is generally recognized that most of the world is a scientific desert, at least in a relative sense. There are some very crude indicators of the global distribution of such effort that might be useful in providing some sense of scale and of why it is that biotechnology is likely in the first instance to have a significant impact on life in industrialized countries.

The last really serious effort to determine global distribution of the particular form of activity in science and technology which matters most in the development and application of advanced technologies—namely, research and development—was undertaken in the mid-1970s. The results indicate that some 97 percent of global R&D expenditures are made in industrialized countries. Within the industrialized countries, furthermore, those activities are concentrated overwhelmingly in the two superpowers, which between them probably constitute some 60 percent of the total and which devote most of their R&D effort to military and other national security-related applications. The remaining 3 percent is equally skewed in its geographical distribution; something on the order of 70-80 percent of that 3 percent is concentrated in a handful of the larger, more advanced Third World countries, such as India, China, Brazil, Argentina, and Mexico.

There is another way of looking at the global distribution of scientific effort. In many ways it is a more meaningful one because international comparisons of R&D expenditures are fraught with perils and uncertainties. That is to look at the global distribution of R&D personnel. Here we find that in the mid-1970s, approximately 12 percent of R&D personnel worked in developing countries and the remaining 88 percent in the industrialized countries. This may, in fact, be a better indicator of the relative distribution of R&D activity on a world scale.

We do not have satisfactory time series data to plot trends, but we can do so in a very crude kind of way. A survey done by the University of Sussex in the mid-1960s suggested that something on the order of 2 percent of R&D expenditure took place in Third World countries. This implies a growth rate for a decade on the order of 50 percent—i.e., an increase from 2 percent to 3 percent. If we applied that same growth rate to R&D personnel, it is possible to argue that by the turn of the century there might be a kind of rough parity—assuming, of course, that growth rates in Third World countries remain at the same level for the balance of this century. (From what data we do have on major Third World countries, we know that, by and large, their pools of scientific and technical manpower are growing more rapidly than those of the industrialized countries.) But what these quantitative growth trends overlook is the qualitative gap manifested in the much more rapid progress of late 20th century technological revolutions such as in biotechnology. While qualitative gaps are by definition very difficult to measure quantitatively, there are a number of indicators to suggest that this gap is growing wider.

This then is the global context within which the revolution in biotechnology is occurring. It involves three categories of institutions—the first are universities (along with the public sector R&D institutions) where much of the basic research on which the technological applications mentioned earlier are based is being and has been done.

The second major category of R&D activity within industrialized countries comprises smaller, venture capital R&D biotechnology companies, the Genentechs and the Cetuses on the U.S. scene and their counterparts elsewhere. These companies are relatively small in size. Most of them are privately held, at least in their earlier stages, and they usually have very low levels of capitalization. Their principal products are R&D consultancies and services. There are a few—Genentech is perhaps one of the best known—that are striving to become manufacturing companies as well. Whether they succeed remains to be seen. That is because of the overshadowing impact of the third major category of actors in the global structure of biotechnology and the biotechnology industry—the multinational or transnational corporations (MNCs and TNCs).

One way to illustrate the significance of MNCs or TNCs is to describe briefly what is happening in the seed industry worldwide. One of the striking characteristics of the seed industry in the last five to 10 years is the degree to which it has become absorbed by TNCs in petrochemicals, pharmaceuticals, and other fields. The largest seed producer in the world today is the Anglo-Dutch petrochemical conglomerate, Shell, which has a stable of some 70 seed companies worldwide, acquired mostly within the last decade.

The second largest corporation in the seed industry is the Swedish automotive manufacturer, Volvo, which is engaged in an interesting process of diversification and now owns or controls some 47 seed companies. The third is indeed a legitimate seed company, Pioneer Hybrid, which nonetheless has broadened its outreach considerably by acquiring in recent years some 38 other seed companies. That is followed by the Swiss chemical and pharmaceutical company, Sandoz, with some 36 seed companies. Others among the 10 largest corporations in terms of their holdings in seed companies include Ciba-Geigy, Upjohn, and Cargill, all of which have moved in a rather aggressive way into the seed industry.

There are good reasons why TNCs that are interested in the potential of biotechnology are moving into the seed industry. They see seeds as delivery vehicles for other kinds of products. The French agricultural journal *Cultivar* recently devoted a special issue to the restructuring of the global seed industry. From that analysis and other data sources, the International Coalition for Development Action newsletter, *Seedling*, reached four conclusions:

1. It is clear that the large TNCs, especially those with main interests in pesticides, pharmaceuticals, and petrol, are increasingly winning control over the whole sector. The renewed interest of some new TNCs in the sector is mainly because of developments in biotechnology.
2. The large "traditional" private vegetable and agricultural seed companies are increasingly linked to TNCs through equity investments by the latter or through direct takeovers. A few very large ones might serve as an exception and stay in the race independently.
3. The large agricultural cooperatives—e.g., Suikerunie and Cebeco from Holland, and Limagrain—are especially important in Europe. Several of them have successfully increased activities through internationalization. But those that are working with cereals are very much threatened by TNCs like Shell, Rohm & Haas, and Monsanto, which are leading the research on hybridization of cereals. When the first cereal hybrids appear on the market, the position of those cooperatives will be in danger.

4. Finally, the role of medium and small companies has declined to almost zero because of lack of capital and research and facilities. In a few special cases small companies might retain some local or regional importance.

For developing countries the situation can be more briefly described because there is far less activity there. Only a handful of the larger and more advanced countries are actively involved. These countries have perceived the potential impact of biotechnology on their own future efforts to meet the needs of their societies and have developed national programs of some kind in biotechnology. Farthest along in their evolution are probably India, Mexico, and Brazil, but several other countries also have staked out areas of public policy concern in science and technology and have established, at least on paper, national programs or strategies in biotechnology. These include Thailand, Argentina, and the Philippines. Almost all of the activity in biotechnology in the developing countries is in the public sector either in research institutions or in the universities. There is a little bit of emerging activity supported by what might be described as venture capital in Brazil, but it is not the general pattern.

Given this configuration of the global effort in biotechnology, it is not difficult to discern the dominant forces that are shaping its present development and are likely to continue to do so through the balance of this century, if not beyond. These forces are rooted in the profit-maximizing, risk-minimizing objectives of industrialized country-based TNCs in petrochemical, pharmaceutical, and other industries and are closely linked to national security concerns of industrialized country governments through both military applications and the presumed security objectives of maintaining an international competitive position in an arena of rapid technological change with enormous economic and military potential. These forces in turn reflect consumer tastes and desires in the rich countries. All of these forces, taken together, have singularly little to do with the wants, let alone needs, of poor majorities in the Third World.

A recent story in the *New York Times* (October 29, 1986), headlined "Consumer Tastes and U.S. Aid Spur Fish Farm Boom," underscores the impact of such forces and their adverse impact on poor people in the Third World. Fish farming or aquaculture, which goes back at least 4,000 years in China and other centers of ancient civilization, is entering a new era of "factory farming". Applying techniques that portend even greater changes as some of the more advanced forms of biotechnology are applied, scientists are growing fish twice as fast as they grow naturally, cutting their feed requirements by nearly half, and raising them on diets that include products previously regarded as waste. Since 1975, the production of "farmed fish" has increased fourfold.

Much of the growth has been in response to rapidly rising consumer demand, and has been aided and abetted by extensive government subsidies of the R&D costs involved. And the motivation for consumer demand is an increasing awareness by health-conscious Americans that protein in the form of lower-fat fish is much better for them than high-fat beef and pork.

Fish farming is, of course, only one example of what lies ahead as the revolution in biotechnology comes more fully upon us. But it manifests itself through the same kinds of forces that will almost certainly accelerate a process begun with the first Green Revolution 20 years ago—namely, the worldwide industrialization of agriculture. To understand what impact this phenomenon is likely to have on Third World countries generally, and the poor within those countries more specifically, it is necessary to look backward at that first Green Revolution, which in many ways can be said to have laid the foundation for the second Green Revolution in biotechnology that will soon be upon us.

REMEMBERING THE PAST: LESSONS FROM THE FIRST GREEN REVOLUTION

The link between the first and second Green Revolution has been succinctly stated by one of the leading architects of the first, the Rockefeller Foundation, in its 1985 Annual Report:

> The use of science and technology to produce improved crop varieties has proven to be an effective means of increasing food production and stimulating economic growth in the developing world. Now recent advances in cellular and molecular biology offer the possibility of dramatically increasing the efficiency, precision, and productivity of classical plant breeding. The combining of conventional breeding and new genetic engineering techniques open the way not only to significant improvements in crop yields, but also to the *development of varieties that allow for broader and more equitable distribution of benefits.* [p. 12; emphasis supplied.]

But will the second Green Revolution, based on biotechnology, lead to "broader and more equitable distribution of benefits," let alone fairer distribution of the costs? Everything we know about the first Green Revolution suggests otherwise. And learning the lessons of the first Green Revolution is crucial if we are to avoid a social disaster of even greater magnitude the next time around. As the philosopher George Santayana wisely observed, "Those who cannot remember the past are condemned to repeat it." (*The Life of Reason*, 1905-1906, Vol. I, *Reason and Common Sense).*

The Rockefeller Foundation claim that the first Green Revolution increased food production and stimulated economic growth in the Third World conceals more than it reveals. What we really need to know, for that claim to have any meaning, is who consumed the lion's share of the increased food production. How was the production of non-food crops affected by the introduction of input-intensive agriculture characteristic of the first Green Revolution? What were the opportunity costs for pursuing this strategy of agricultural production in terms of displacement of traditional crops and subsistence farmers? How were the benefits of economic growth distributed within Third World societies and between the Third World and the industrialized countries? What were the political and ecological, as well as social and economic costs, and who bore the brunt of these?

What can be said with some confidence is that the diffusion of Green Revolution technology was very rapid. Acreage planted in high-yielding varieties of rice and wheat, the two principal crops affected, at least in the earliest stages of the Green Revolution, increased from virtually zero in 1965 to more than 80 million acres in 1973 in Asia and North Africa. India doubled its wheat crop from 1966 to 1972, while wheat production in Mexico tripled through the 1950s and 1960s. (Buttel and Humphrey, p. 211).

The net impact of the Green Revolution on food supplies in the Third World overall has been, however, quite limited for several reasons, and even where it did have significant impact, the benefits have been strikingly skewed. The climatic and soil requirements of improved varieties have severely circumscribed their application. Outside of Taiwan and Mexico, only 17 percent of wheat acreage and 10 percent of rice acreage in non-socialist Third World countries was by 1972 planted in high-yielding varieties. Less than 7 percent of food grain acreage in non-socialist Third World countries overall was by that time devoted to high-yielding cereals. (Buttel and Humphrey, pp. 211-212).

But there are other characteristics of Green Revolution technologies that resulted in skewed access to and therefore benefits from these technologies. A significant quality of Green Revolution crop varieties is their responsiveness to chemical fertilizers. But for the fertilizers to be effective, these

varieties also require other inputs, especially sufficient water and pest control. While the technologies can be used in theory with more or less equal results on small family farms and large corporate farms, leading some to claim that these technologies are "scale-neutral," the reality is that only large farmers and land owners have had access to all of the inputs necessary to assure that these high-yield varieties would in fact deliver the yields of which they were capable. (Buttel and Humphrey, p. 211).

Acquisition of these essential inputs depended in no small measure on access to credit. Credit systems in many Third World countries are heavily biased against small and marginal farmers, let alone landless agricultural laborers. Large farmers and land owners thus were able to finance the needed inputs by favored access to credit or through their own accumulated capital. This led to a further concentration of resources in the hands of the larger agricultural operators, enabling them to push for greater mechanization which, although not "conceptually" an inherent element in the first Green Revolution, followed inescapably in the wake of these other changes. That agricultural mechanization was also handsomely supported by international development agencies such as the World Bank; building new markets for a TNC-dominated agricultural machinery industry simply accelerated the process. This in turn led to displacement of agricultural labor, while the overall accumulation of resources helped the large farmers become still larger, allowing them to evict their tenants and to purchase land from small-farming neighbors. (Buttel and Humphrey, p. 212).

Third World governments, all too often egged on by industrialized country-based development agencies, gave further impetus to this process of increased concentration of ownership of productive resources in the countryside. Government subsidies of high-yielding varieties, which had the net effect of artificially reducing the actual cost of producing these varieties, obviously were going to benefit most those farmers planting such varieties. Furthermore, governments frequently insisted upon a "package" of inputs and practices—not illogically insisting that the other inputs such as water and pesticides be available along with the improved varieties so that higher yields would result. But the net effect, because of the bias in credit systems, was generally to limit access to these "packages" of help to larger farmers.

The social impact of these phenomena was inevitable. Rural class structures in many Third World countries have been both more polarized and more differentiated. Polarization is reflected in the increased concentration of land, wealth, and income that has emerged in many rural areas in the Third World in the last two to three decades. (C.T. Kurien, *Tamil Nadu: The Dynamics of Rural Transformation).*

Differentiation of class structure manifested itself in the "decomposition" of the peasant class of farmers into a smaller number moving up to becoming "middle peasants" who produce a marketable surplus and employ labor and a much larger number moving down into the small and marginal farmer class where they practice subsistence level farming using only their own family labor, becoming agricultural laborers who are merely a landless proletariat selling its labor to dominant landed elites or middle peasants. Tenant farmers are disappearing altogether as rising rents reflecting increased land prices drive them off the land. The net result is that rural income increasingly has been generated by accumulation of capital and ownership of land, while real wages from agricultural labor have at best held steady, and in many instances actually declined. (Buttel and Humphrey, p. 213).

But the impact of the Green Revolution is not limited to adverse social and economic effects. As Buttel and Humphrey observe, "many nutritionists consider the Green Revolution a protein disaster." High-yielding varieties of cereals generally achieved their higher yields at the expense of lowered

protein content. At least as important is the fact that these varieties often displaced legumes, an important source of protein in the diet of many Third World poor. This same displacement phenomenon also reduced the contribution of nitrogen fixation to replenishing the nutrients in the soil, leading to still greater dependence on chemical fertilizers.

Another set of adverse ecological effects is related to the restricted genetic base and lack of native immunities in high-yielding varieties. As a consequence, these varieties are less resistent to diseases, pests, and drought than the local and traditional varieties they replaced. Initial increases in yields, which seemed dramatic at first, often dissipated over time as pest infestations intensified. In an effort to contain losses, pesticide applications increased, not only escalating the farmer's costs and his dependence on outside suppliers, but also poisoning the environment, especially ground water supplies. Other consequent ecological problems were increased erosion owing to the cessation of crop rotation and water shortages caused by greatly expanded irrigation. (Buttel and Humphrey, p. 213).

As if the social, economic, and ecological effects were not enough, the Green Revolution had political repercussions as well. As Francine Frankel has demonstrated in her work on India and Pakistan, the concentration of land, wealth, and income in rural areas has led to the increased political dominance of large land owners. The struggle between the rich and the poor in the countryside for access to productive resources, unequal under the best of circumstances, has become all the more so. (Frankel, 1973)

Yet another political impact of the Green Revolution has been the penetration of transnational fertilizer, machinery, and other agribusiness firms in Third World economics. Many capital-scarce Third World countries were not able to afford their own fertilizer plants and had to obtain the critical chemical fertilizers through imports. Even when they were able to build their own fertilizer plants, the investments and technology usually were tied to an outside source, perpetuating dependence on external institutions. One manifestation of this situation is the Third World debt crisis, with all of the adversity it has brought to low-income people in the Third World. (Caesar Espiritu, "Transnational Agribusiness in the Third World," in ICLD, *International Context of Rural Poverty in the Third World.)*

That the first Green Revolution had significant impact on the Third World is indisputable. But the distribution of its costs and benefits is a classic manifestation of the "Refraction Effect" in which the benefits of technological change as they are passed through the fabric of an established social order are distributed in rough proportion to the existing distribution of productive assets and power within that social order. (Morehouse, *Science and Public Policy).* To express the overall impact of the first Green Revolution another way, "the disadvantages have been quite widespread while the benefits have been more localized." (Buttel and Humphrey, p. 214)

The socially and environmentally perverse consequences of the first Green Revolution were exacerbated and reinforced by the global political economy and its impact on the rural poor in the Third World. Some of the characteristics of the larger political and economic environment and the ways in which it affects the poor in the Third World have been examined by various contributors to a recently published ICLD volume, *The International Context of Rural Poverty in the Third World.* Many of the harms done are documented and described in this volume: displacement of small and marginal farmers from their lands, diminishing real wages for agricultural labor, loss of markets for traditional crops, and environmental destruction resulting from the input-intensive agriculture characteristic of the first Green Revolution. These harms are compounded by the growing worldwide industrialization of agriculture which has markedly increased the penetration of the Third World countryside by

external actors such as transnational agribusiness, international development agencies, and industrialized country governments. (ICLD, *Rural Poverty*, especially the chapters by Espiritu, Green Alvares, and Kothari.)

After an initial euphoria over the first Green Revolution in the 1960s and early 1970s, more and more critical attention was focused on the longer term social, economic, political, and environmental impacts of this strategy. By now the principal lessons from that deliberately induced "revolution" in agricultural technology are well documented and readily enough evident for all who wish to see them. Even the Rockefeller Foundation, which, along with the Ford Foundation and international development agencies such as USAID and the World Bank, played such a key role in that revolution, acknowledges the critical importance of working toward "more equitable distribution of benefits" from the coming second Green Revolution in biotechnology. (Rockefeller Foundation, 1985 Annual Report, p. 12)

But a further inspection of what the Foundation is actually doing does not sustain much hope that the mistakes of the past will not be repeated. Out of all of the various grants in agriculture made by the Foundation in 1985, only two or three appear to be directed toward the problem of achieving a "more equitable distribution of benefits". And those take a technocratic approach characteristic of development agencies like Rockefeller, supporting further study and analysis by social scientists, many of them alien to the societies they are studying, while failing to support action that will lead directly to greater participation by the Third World poor in shaping this coming technological revolution so that it will genuinely serve their own needs and wants. (Rockefeller Foundation, pp. 12-22)

BIOREVOLUTION IN THE THIRD WORLD: A SECOND GREEN REVOLUTION?

Will the revolution in biotechnology, when it hits the Third World, be another Green Revolution? If so, what is likely to be the predominant social impact? Is it likely to weight the scales of development on the side of growth at the expense of equity and sustainability as did the first Green Revolution? Or will this revolution tip the scales the other way?

The answers to these questions cannot be provided with certainty today because they all lie in the future. There are, however, some characteristics of and trends in the biotechnology revolution which, if they are not altered soon, will likely have an adverse impact on equity and sustainability. In addressing the outlook for biotechnology in the Third World, we need to begin by looking at significant characteristics of the development of biotechnology in the industrialized countries where most of the activity is occurring. We already have noted the growing concentration of ownership and control of activities related to the industrial applications of biotechnology.

Closely related to that phenomenon are privatization of critical knowledge in biotechnology and the creation of property rights through patent-like protection of plant varieties and actual patent protection of novel micro-organisms. Such protections are critical elements in the strategic planning of the TNCs, which, in a risk-minimizing, profit-maximizing effort, are trying to maintain barriers to entry by competitors and competitive products. They are simultaneously trying to establish significant market control or at least influence, because that enables them to develop relatively secure or stable markets over longer periods of time and of course to maximize their profits.

One major area of concern in the biotechnological revolution involves limitations of access of Third World countries to technology appropriate to their social and economic priorities and their human needs. What is occurring is not at all surprising. In the current circumstances, the applications of biotechnology are certainly going to come first to those markets which are perceived to be the largest and are populated by those who can afford to pay for the products thus developed.

There are also substantial government obstacles to access. They grow partly out of some of the potential applications of biotechnology, which make it susceptible to being characterized as "strategic technology" not unlike some areas of microelectronics. Not long ago a U.S. Government Interagency Working Group on Biotechnology produced a report that looked at a wide range of policy options to maintain or "retain U.S. leadership in biotechnology" (the words of the Interagency Working Group). Among the options examined were export controls and licensing, as well as efforts to establish reciprocity in exchange of both knowledge and experience or training opportunities. These are effective ways of keeping international interchange in biotechnology in the hands of the few nations that are producing most of this knowledge. Countries not on the fast track in biotechnology have very little to offer the United States, while other countries, such as Japan which is mounting a major effort to develop its capabilities in biotechnology, have much to offer.

What might be called biohazards are another concern. These are workplace hazards of dealing with substances of unknown toxicity; hazards to consumers from prolonged exposure to products the character of which, in terms of its impact on human beings, is not well understood; and environmental hazards which many believe are just as worrisome because we are dealing with new organisms, and releasing them into the environment may permit them to reproduce themselves at will and without restraint with negative environmental consequences. This last is of course the subject of Jeremy Rifkin's several lawsuits in which he asserts that inadequate effort has thus far been given to determining what the impact of novel organisms will be.

Finally there is the critical question of product displacement in developing countries. We are already seeing some of this occur, and it is predictable that we will see more of it in years ahead. Biotechnology creates the possibility of what has been called factory farming in industrialized countries, clearly a risk-minimizing, even if not necessarily profit-maximizing, strategy for TNCs that can produce through tissue culture techniques many products that are grown naturally in the Third World.

Such product displacement already has occurred in the international sugar market with the development of high fructose corn syrup as an alternative to sugar in many industrial applications. The net effect is to hold the world price of sugar—a vitally important export commodity for several Third World countries—hostage to the price of corn or maize in the U.S. and several other industrialized countries. But in the future, the most vulnerable Third World products are more likely to be those that involve a high unit cost since the higher the cost of the natural product from the Third World, the easier it will be to utilize "factory farming" methods in the industrialized countries in producing alternatives.

MINIMIZING HARMS AND MAXIMIZING BENEFITS FOR THIRD WORLD PEOPLES: SOCIAL, POLITICAL, AND LEGAL POLICIES AND ACTION STRATEGIES

For all of the many obstacles to be overcome, a Luddite stance by the Third World on the

coming biorevolution would be a mistake. That revolution bids fair to becoming so pervasive that it will engulf Third World countries, regardless of what kind of response and initiatives they take.

The challenge is to develop appropriate strategies deliberately designed to further self-reliant, equity-enhancing, sustainable development and to advance the fundamental human rights mentioned at the beginning of this paper. There are policy options and action strategies to be pursued by those committed to equity and sustainability in the development process.

The most obvious, of course, as in any other area of potentially revolutionary technology, is to develop an indigenous capability or capacity. There is no substitute for internal capacity, as people concerned with these issues in developing countries know all too well. We also need international institutions that are genuinely responsive to Third World concerns. The potential importance of an institution like the International Center for Genetic Engineering and Biotechnology (ICGEB) being set up under the auspices of UNIDO, even in the face of all of the contraints of creating a new institution through the UN system, cannot be overemphasized. Here is an institution that has the potential of providing a vitally needed Third World window on an area of rapidly emerging technology in the industrialized countries—a Third World window that has at least the possibility of being largely controlled by Third World countries.

Moreover, Third World countries need to develop strategies for resisting the trend toward privatization in the principal industrialized countries which has been only briefly mentioned here, and to develop early warning systems to anticipate likely areas of product displacement in order to develop defensive strategies for dealing with this problem within their own societies. Perhaps most important of all is the need to develop R&D programs that are deliberately and significantly biased toward the poor, so that the application of this revolutionary technology can indeed benefit those most in need.

In addition, Third World countries need to develop a variety of information systems that will maximize their knowledge and awareness of what is going on in the industrialized countries relevant to their concerns. Such information systems will be more effective if they are linked to appropriate counterpart agencies in the industrialized countries. This is a particularly fitting role for institutions like the Academy for Educational Development, which function as brokers between Third World institutions and knowledge-generating institutions in the U.S. and other industrialized countries.

The foregoing policy options and related initiatives need to be translated into concrete political, social, and legal actions if the potential of the second Green Revolution to help the hundreds of millions of Third World poor is to be realized. An important first step is critical analysis of the actual distribution of costs and benefits of development initiatives, especially those that seek to draw significantly on practices and methodologies of biotechnology, whether directly or indirectly. All too often the promoters of such development initiatives proclaim that they will benefit largely the rural poor. These claims must be *independently* substantiated by organizations of the rural poor and social action groups, and if it cannot be sustained, systematically and aggressively exposed. Such exposure is best accompanied by advocacy of concrete and positive alternatives that will in fact benefit the rural poor.

Where large numbers of poor persons have been displaced by rural development projects and have lost their traditional means of support, participatory organizations of the rural poor (PORPs) and social action groups (SAGs) should work toward obtaining alternative means of livelihood for these people and assuring that promises of adequate compensation are actually fulfilled. Sometimes,

supporting actions—such as consumer boycotts in urban areas of products produced through "new-style" agricultural technologies—can be an effective means in the struggle for greater justice for those who are displaced by these interventions in their lives. Yet another set of action strategies involves efforts to improve the quality and productivity of traditional techniques of producing food, instead of abandoning these techniques entirely to so-called modern alternatives which, as we have seen in our examination of the first Green Revolution, all too often deprive the rural poor of control over even the most meager productive resources. (See Editor's Note in ICLD, *Rural Poverty*.)

Closely related to such action strategies are endeavors to use the law as an instrument for protecting and advancing the rights and interests of those threatened by the onslaught of imported revolutions in technology such as the first Green Revolution and the forthcoming one in biotechnology. These have been discussed in recent papers by Upendra Baxi ("Law, Struggle, and Change in India: An Agendum for Activities") and Clarence Dias and James Paul ("Developing Legal Strategies to Help Combat Rural Impoverishment: Using Human Rights and Legal Resources") in the ICLD volume, *The International Context of Rural Poverty in the Third World*, and need be only briefly summarized here.

At the heart of efforts to strengthen and use the law and legal institutions as instruments for social justice is growing recognition, prompted by tragedies such as the Bhopal disaster in India, that the victims of development harms must have power to protect themselves if they are going to be protected at all. The critical need is to empower victims to demand remedies that will enable them to realize the "universal" rights promised by various international conventions such as the Universal Declaration of Human Rights, as well as by national constitutions and other sources of law, let alone those set forth in the rhetoric of development plans and "official" ideologies. Three key tasks are involved:

1. Identifying harms which are the frequent result of particular development initiatives (such as those generated in the name of the first and second Green Revolutions) and pinpointing practices of both international and local actors which cause these harms.
2. Developing necessary self-help strategies to prevent these harms or remedy them when they have occurred.
3. Developing human rights and other areas of the law to protect and promote these strategies.

Among the harms caused by development initiatives are landlessness, indebtedness, exploitation (of the less powerful by the more powerful—e.g., various forms of bondage instead of wage labor that will sustain a decent living standard), and repression. Legal strategies to combat such harms cover a wide range. Land alienation legislation and land reform laws protecting the rights of small land owners need to be enacted if they do not already exist, and where they do exist, meaningfully enforced (a task which frequently requires the intervention of socially concerned legal practitioners with access to the court system). But it is crucial in such initiatives that the people themselves understand their rights and demand fulfillment of those rights in accordance with the law so that they are not again dependent on external actors, even well-intentioned ones.

Similar initiatives can be taken to combat other harms, such as indebtedness. There may already be legal measures to prevent extracting usurious interest rates, but where traditional lending occurs outside of the formal banking system, these measures are rarely enforced. Where there is large-scale crop or market failure for reasons beyond the control of the debtor, debt relief measures should provide for moratoriums or rescheduling to reallocate some of the burden of the risks involved. And

in a similar manner, labor welfare laws dealing with wages, hours, workplace hazards, and the like—which again often exist on the statute books in many developing countries—can be more rigorously enforced to protect the rural poor against exploitation.

The effective utilization of the law to protect the poor and assure that they receive appropriate benefits from the Green Revolutions of the past and the future involves several different kinds of law—international law, tort and contract law, constitutional law within the country concerned, and indigenous law based on customs and widely shared values within a particular community. Human rights law, including the rights promised by the Charter of the United Nations, the Universal Declaration of Human Rights, the International Covenants of Human Rights, and various other international conventions promulgated through the UN system, including the ILO, offer a particularly promising area for applying law to the needs and concerns of the rural poor. The body of human rights law guarantee the rights of all people, including the rural poor, to food, shelter, education, and health care. Most importantly, for any approach that emphasizes participation and empowerment, it guarantees the rights of rural producers and women to form self-managed organizations of their own choice without interference by organs of government.

It is, however, relatively meaningless to talk about the "right of participation" unless there is a body of concrete component rights and enforcement procedures—hence, the vital importance of developing specific protections and remedies to go along with human rights and other forms of law to aid and protect the rural poor. "Participation" may thus be realized through the right to vote, the right to join a trade union or other interest group, independent media and press freedoms, and access to the courts to protect these rights. Another category of component rights concerns rights to information that vitally affects the welfare of the rural poor and rights of access to decision-makers in relevant government agencies, to international organizations, and to the courts to enforce these rights, as well as rights to publicize grievances.

Finally, it is important to strengthen legal resources that will enable the rural poor to use the law to protect themselves and promote their shared interests. Development of such resources involves generating knowledge—a far bigger task than is often recognized—and developing advocacy. These in turn can lead to strategic action campaigns to ensure fair compensation to victims of development projects undertaken in the name of technological revolutions and to insist that national agencies and international development organizations can be held accountable for their actions.

All in all, these various initiatives constitute a formidable agenda for assuring that the next Green Revolution will succeed where the first Green Revolution failed by bringing to those hundreds of millions of persons most in need the extraordinary life-enhancing potential of the new technology. Given the existing configuration of power at the local, national, and international levels, alas, it is morely likely that George Santayana's admonition may be ignored. But those who have not forgotten must not abandon the struggle. For if they do, they will surely be corrupted by the same forces that oppress the poor as they strive to bring them the "benefits" of twentieth century technological revolutions.

Notes:

In addition to the sources cited in the text, this paper draws extensively on three papers by David Dembo, Clarence Dias, and Ward Morehouse:

"Toward Third World Policies and Strategies to Address Social Concerns Relating to Biotechnology" (Discussion Paper prepared for the World Food Assembly, November 1984)

"Biotechnology and the Third World: Some Social, Economic, Political, and Legal Impacts and Concerns,"*Rutgers Computer and Technology Law Journal*, Vol. II, No. 2, 1985.

"The Biorevolution and the Third World," *Third World Affairs, 1985*, London: Third World Foundation, 1985.

The paper also reflects the work of various contributors to David Dembo, Clarence Dias, Ward Morehouse, and James Paul, eds., *The International Context of Rural Poverty in the Third World: Issues for Research and Action by Grass Roots Organizations and Legal Activities*, New York: Council on International and Public Affairs, 1986 (International Center for Law in Development Series on Law, Social Action, and Rural Poverty, No. 1).

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